Forest Insect & Disease Leaflet 169

U.S. Department of Agriculture • Forest Service

Larch Dwarf Mistletoe

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Larch dwarf mistletoe (Arceuthobium laricis (Piper) St. John) is a common and damaging parasite of western larch (Larix occidentalis Nutt.) in the Pacific Northwest and southern British Columbia. Larch dwarf mistletoe occurs commonly throughout the range of western larch in British Columbia, northern and central Idaho, western Montana and east of the Cascades in Washington and Oregon (figure 1). Surveys of national forests in this "Inland Empire" indicated that about 35% of the western larch forests in this region are infested and that nearly 50% of the larch forests in eastern Oregon and Washington are infested with larch dwarf mistletoe. Because of its widespread occurrence, its high incidence in larch forests, and the impacts associated with high levels of infection, larch dwarf mistletoe is considered to be the most important disease of western larch.

Although western larch is the principal tree species affected by larch dwarf mistletoe, it also parasitizes several other tree species in several different genera. Mountain hemlock (Tsuga mertensiana (Bong.) Carr.) is severely parasitized in the Bitterroot Mountains of northern Idaho and western Montana. Lodgepole pine (Pinus contorta Dougl. ex Loud. subsp. latifolia (Engelm. ex Wats.) Critchf.) is frequently parasitized when growing in association with infected western larch. Subalpine fir (Abies lasiocarpa (Hook.) Nutt.), ponderosa pine (Pinus ponderosa Laws.), and Pacific silver fir (Abies amabilis (Dougl.) Forbes) are occasionally parasitized. Larch dwarf mistletoe rarely infects grand fir (Abies grandis (Dougl. ex D. Don), Engelmann spruce (Picea engelmanii Parry ex Engelm.), western white pine (Pinus monticola Dougl. ex D. Don), whitebark pine (Pinus albicaulis Engelm.), or western hemlock (Tusga heterophylla (Raf.) Sarg.). Douglas-fir (Psuedotsuga menzeisii (Mirb.) Franco.) is immune to infection by larch dwarf mistletoe.

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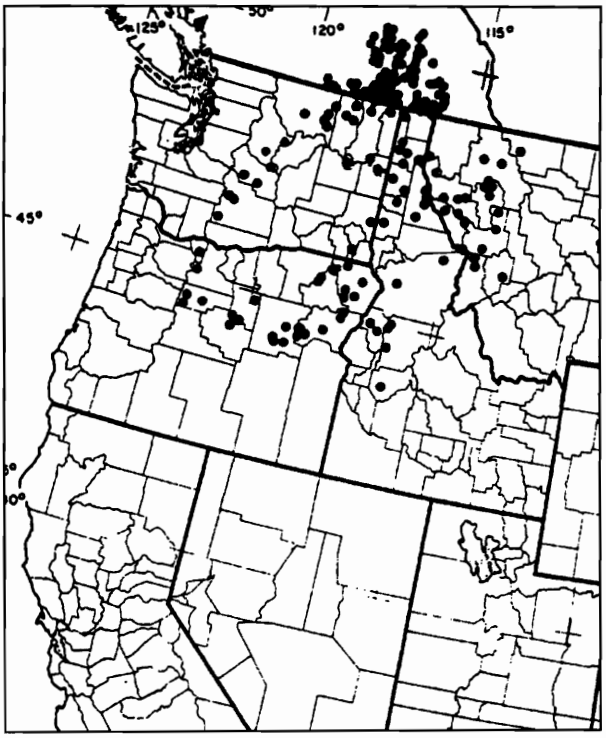

Figure 1 - Distribution of larch dwarf mistletoe.

Life History

Larch dwarf mistletoe is a small, parasitic flowering plant. The external (aerial) shoots are light brown to dark purple, leafless, and perennial. Their average height is only about 2 inches (5 cm), but they are sometimes as tall as 4 inches (10 cm) (figure 2).

Aerial shoots arise from a network of root-like, absorbing strands embedded in host tissues. This network, called the endophytic system, consists of cortical strands growing within the bark and sinkers within the wood. The endophytic system extracts nutrients and water from the host tree. The endophytic system lives as long as adjacent host tissues are alive. Even though the aerial shoots contain chlorophyll that produces small amounts of carbohydrates, the mistletoe is dependent upon its host for water and nutrients.

The major function of aerial shoots is reproduction. Male and female flowers are small and produced on separate plants. Flowering takes place in July and August. Both insects and wind are involved in pollination.

Fruits complete development within 13 to 14 months after pollination. Mature fruit contain one seed averaging less than 0.1 inch (2 mm) in length but several seeds develop on each shoot. Seeds are discharged explosively from mature fruits in September and October. They may travel 35 to 45 feet (12 to 15 m), but most land within 10 to 15 feet (3 to 5 m) of the parent plant. A sticky, hygroscopic seed coating called "viscin" enables seeds to stick to most objects they strike. Most seeds land on foliage. Viscin, when first moistened by rain, acts as a lubricant. Seeds slide down and either fall off needles or become lodged on bark at the base of needles. Fastened in place on small branches when the viscin dries, seeds overwinter in a dormant state. Seeds are often destroyed by insects and fungi, or dislodged by rain and snow, so only a small proportion of seeds actually survive and cause new infections.

Seeds germinate in early spring. Radicles grow along the bark surface until an obstruction, usually a needle base, is encountered. The radicles then form mounds of tissue called "holdfasts." Host tissue is then penetrated by infection pegs that develop

from the holdfasts during the summer. The mistletoe's endophytic system then develops in the bark and wood of the host. Infection occurs most readily in 1- to 5-year-old twigs because their bark is more easily penetrated than older twigs.

Aerial shoots typically appear 2 to 3 years after initial infection. Infections that have not yet produced aerial shoots are called "latent infections." The typical length of time needed for female plants to complete their life cycle from initial establishment to dissemination of the first seed crop is 4 to 5 years. Many successive crops of aerial shoots may be produced from an established endophytic system.

There are natural factors that affect the distribution of larch dwarf mistletoe, especially wildfires, which have been nature's primary control agent. Also, several species of insects and fungi attack and kill larch dwarf mistletoe shoots or fruits. One of the fungi (Cylindrocarpon gillii (Ellis) Muir), is a common pathogen of larch dwarf mistletoe and may exert considerable local but temporary control. Environmental factors, currently not completely understood, limit its effectiveness to small areas for short periods of time.

Symptoms and Signs of Infection

The first symptom of dwarf mistletoe infection is the appearance of slight swellings at infection sites. Swellings become visible 1 to 2 years after infection occurs. The most striking symptoms of dwarf mistletoe infection on western larch are witches' brooms. Witches' brooms are variously shaped masses of abnormal branch and twig growth (figure 3).

Heavily infected western larch normally develop many small, dense witches' brooms throughout their crown (figure 3). Because the wood of branches that form brooms becomes extremely brittle over time, witches' brooms often break off during the winter when snow accumulates in the brooms and makes them extremely heavy.

Figure 2— Female shoots of larch dwarf mistletoe.

Figure 3— Witches' brooms on heavily infected western larch.

Heavily infested stands typically have many trees with stunted growth, witches' brooms, dying or dead tops, and dead trees. These stands eventually contain numerous dying and dead trees, usually bearing remnants of brooms. Dieback occurs as nutrients and water needed by growing tree tops are diverted to the brooms, which are usually concentrated in the lower or mid crowns. Eventually height growth slows and ceases, foliage above the brooms becomes sparse and off-color, and gradually the tops die. Spike, or staghorn, tops indicate a tree suffering typical decline.

Spread and Intensification

Several interrelated factors influence tree-to-tree spread of larch dwarf mistletoe. These include size class, stand structure, species composition of stands, tree spacing, and infection position. In single-storied stands, lateral spread is estimated to be 1.5 to 2 feet (0.5 to 0.6 m) per year. Spread in multi-storied stands is more rapid because understory trees are bombarded by dwarf mistletoe seeds from infected overstory trees. Infection of western larch less than 10 years old is uncommon. The probability that seedlings will be infected is dependent upon seedling age and density and the level of infection in overstory trees. Presence of non-host tree species can slow the spread of larch dwarf mistletoe. Spread rates in very dense stands are less than in more open stands because dwarf mistletoe seed production is usually poorer due to limited light and poorer host vigor, and many seeds are trapped in the crown.

Nearly all spread is local and results from explosive discharge of seeds. Wind exerts a minor influence on distance and direction of seed travel. Birds and other animals are responsible for some long-distance spread when seeds stick to their bodies and later are rubbed off on to susceptible trees.

The 6-class dwarf mistletoe rating (DMR) system is useful for quantifying severity of infection in western larch trees and stands. For this system, the live crown of the tree is visually divided into thirds and each third rated according to the following scale: 0 = no visible infection, 1 = light infection (less than half of the branches in the third infected), or 2 = heavy infection (more than half of the branches in the third infected). The three ratings are then added to obtain a tree rating from 0 to 6. The tree ratings of all live trees (including uninfected ones) can then be averaged to obtain a stand rating.

As a rough rule-of-thumb, intensification of larch dwarf mistletoe averages

about 1 DMR class per decade for individual trees but varies with tree size and the amount of overstory infection. Infection intensifies most rapidly in sapling or pole-size trees under severely infected larger trees.

Impact

Infection of larch by dwarf mistletoe causes increased mortality, reduced growth rates and loss of vigor, lowered timber quality, reduced cone and seed production, and increased susceptibility to other damaging agents. These damaging effects result from the dwarf mistletoe plants taking food and water from the host, thus reducing the amount available for the tree's normal growth and reproductive processes.

The parasite is often the major factor contributing to tree death. Mortality of western larch in severely infested stands is significantly greater than that in comparable, uninfested stands. Even moderately infested stands show increased mortality rates compared to uninfested or lightly infested stands. Some of the tree mortality is the result of stem breakage and bending due to snow and ice that accumulate in heavily broomed trees.

The effects of dwarf mistletoe on growth increases with severity of infection and is especially acute in severely infected trees (DMR 5 or 6). Tree volume growth can be reduced by as much as 50% in severely infected trees. Quality of lumber in infected trees can be reduced because larch dwarf mistletoe often causes the tree to form burls in the main stems of western larch. Large knots often are associated with branches supporting witches' brooms. Severely infected trees typically produce few cones and those that are produced are smaller than normal and contain fewer viable seeds.

Other forest values can be adversely affected by larch dwarf mistletoe. Large witches' brooms can increase the hazard potential in recreation sites because they may cause branches to break and trees to break and fall. Dead and dying trees can detract from visual quality in scenic areas. Potential for destructive wildfires is increased because of dead branches in witches' brooms, the increased number of dead trees, and the accumulation of dead branches from witches' brooms around the base of infected trees.

Larch dwarf mistletoe infection can also have beneficial effects. Flowers, shoots and fruits are food for insects, birds, and mammals. The large witches' brooms produced in severely infected trees are used for hiding, thermal cover, and nesting sites by hawks, owls, and other wildlife species. The mortality caused by dwarf mistletoe, either directly or by predisposing trees to other agents, provides snags as habitat for cavity-nesting birds and, eventually, coarse woody debris on the forest floor.

Management

In forest ecosystems, dwarf mistletoes have value as individual, biological species and act as disturbance agents, influencing both the structure and function of forest communities. Management based on the effects of larch dwarf mistletoe must recognize the value of dwarf mistletoes as functional components of forest ecosystems in which they occur. In areas where timber production or developed recreation is the primary goal, direct control of dwarf mistletoe may be warranted. In other areas, where non-commodity goals are of paramount importance, different management activities may be appropriate. Some of these activities could be designed to maintain or even increase populations

of dwarf mistletoes for specific purposes.

The key to proper management of this parasitic plant is to recognize its importance in the overall diversity of ecosystems and to devise management alternatives that recognize and maintain that diversity while meeting management objectives.

Cultural Controls

The only practical control of larch dwarf mistletoe over large forested areas is through cultural treatments. No chemical or biological controls are available for treating stands. Profitable production of western larch timber in many local areas often depends upon control of dwarf mistletoe. Because the parasite causes large reductions in yield, control should be considered in all timber-producing stands where it occurs.

Successful timber volume production is almost impossible in multi-storied, severely infested larch stands. Silvicultural treatments designed to achieve single-storied stands offer the best prospects of preventing unwanted losses to dwarf mistletoe. The most effective method for eliminating existing larch dwarf mistletoe from timber-producing forests is complete harvest of infested stands by clearcutting. After usable trees are harvested, all remaining infected trees should be killed. To minimize invasion of young western larch stands by dwarf mistletoe from infected border trees, the ratio of perimeter to area of clearcuts should be as low as possible. That is, they should be roughly circular and not long, narrow strips. Advantage should be taken of any potential barriers to dwarf mistletoe spread, such as roads, ridgetops, natural openings, and changes in timber types when laying out the boundary of a clearcut.

When clearcutting of dwarf mistletoe–infested western larch stands is not appropriate, shelterwood and seed tree harvests can be good alternative even-age management methods. Trees selected to provide shelter or seeds should be uninfected or only lightly infected (DMR less than 3). Moderately and severely infected trees, in addition to being a source of dwarf mistletoe seeds, produce poorer crops of larch seeds. Infected shelterwood or seed trees should be removed as soon as susceptible reproduction becomes established. As a general rule for most dwarf mistletoes it is desirable to remove the infected overstory before the young stand is 3 ft (1 m) tall or 10 years old.

In mixed-species stands that contain western larch infected by dwarf mistletoe, silvicultural treatments should favor other tree species. Nonhosts left between infected and noninfected larch prevent or slow spread and intensification of the parasite.

Thinning or sanitation by removal of infected trees can be an effective treatment in lightly infested stands. Lightly infested is defined as those stands in which there are acceptable numbers of desirable dwarf mistletoe-free or lightly infected (DMR 1 or 2) trees. Western larch with one-half or more of their crown infected by dwarf mistletoe (DMR 3 to 6) may decline rapidly about 10 years after they are exposed to full sunlight by thinning. Because of this risk of rapid decline, moderately infected trees (DMR 3 and 4) should not be left when stands are being sanitized unless they can be expected to reach merchantable size within 15 years. Larch stands with a mean diameter of 9 to 15 in (23 to 38 cm) should be commercially thinned to basal area levels of about 90 ft2/ac (21 m2/ha) to increase growth and vigor of lightly infected trees and still

meet minimum stocking levels for larch. In smaller-diameter stands, precommercially thin to improve stand vigor after removing infected overstory trees following the selection guidelines described above.

Latent dwarf mistletoe infections in trees in densely stocked stands and in shaded reproduction are very difficult to detect. It should be assumed that understory trees more than 4 feet (1.3 m) tall that have been overtopped by infected trees for at least 15 years are probably infected.

Recreation Management

In recreational forests, sanitation treatments that favor nonsusceptible hosts or remove infected overstory trees are appropriate. Pruning can prolong the life of individual, lightly infected trees but any severely infected neighboring trees must also be removed to prevent reinfection. For high-value trees, removal of live witches' brooms which exert a large drain on infected trees can improve their vigor and prolong their life. Trees may have to be repruned occasionally to remove developing witches' brooms. The best candidates for pruning are trees with infections only in the lower half of their crown. In addition to prolonging tree life, pruning can reduce the danger of trees or branches breaking and causing damage to people or buildings.

Assistance

Resource managers can get more information about the identification and management of larch dwarf mistletoe by contacting a County Cooperative Extension agent, their local state forestry office, or their regional USDA Forest Service, Forest Health Protection (FHP) office.

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R6-FID-PR-009-97